Express Mailing Label No. EM521656714US

PATENT APPLICATION
Docket No. 11675.168

UNITED STATES PATENT APPLICATION

of

LEONARD E. MESS

for

THERMALLY CONDUCTIVE INTERPOSER AND METHOD

09123963 . 072298

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

BACKGROUND OF THE INVENTION

1. The Field of the Invention

This invention is in the field of semiconductive device technology. More specifically, this invention is in the field of interposers for electrically connecting semiconductive devices to an electrical apparatus.

2. The Relevant Technology

A semiconductive device is often electrically coupled to an electrical apparatus such as a computer through the use of an interposer. In one such process, the semiconductive device is connected to the interposer, which is then inserted into the socket of the electrical apparatus. The socket may be mounted on the motherboard of a computer, for example. Thus, the semiconductive device communicates electrically through the interposer with the electrical apparatus. Typical interposers currently employed in the coupling of semiconductive devices to electrical apparatuses are comprised of an FR4 fiberglass material, or the like, having electrically conductive metal lines or traces thereon.

The term "semiconductive device" extends to any device or assembly that includes circuitry defined in a semiconductive material, and further extends to a chip package that includes semiconductive material. The external and additional structure of a package assembly may be used, for example, for mounting the semiconductive device to a printed circuit board or other external circuitry, for establishing electrical connection between the semiconductive device and external circuitry, for improving the ease of handling or transporting the semiconductive device, and/or for protecting the semiconductive device from environmental conditions. Many chip packages include a lead frame that extends beyond the body thereof. The lead frame typically includes an array of electrical leads that extend from the internal circuitry of the integrated circuit to the exterior portion of the chip package where they are exposed to the surroundings.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

Frequently, after a semiconductive device is manufactured, a testing process is conducted on the semiconductive device by subjecting it to a preselected set of input conditions in order to measure its response or other parameters. Testing of an integrated circuit package that includes a lead frame assembly is conventionally conducted by providing temporary electrical communication between the leads and testing circuitry. For example, such temporary electrical connection may be established by using a set of probes, pins, sockets, or the like, to contact the leads. The integrated circuit package may be clamped or otherwise secured in position during the testing operation in order for the leads to remain in electrical contact with the corresponding probes, pins, sockets, etc., of the testing circuitry.

Semiconductive devices, such as DRAMs and SRAMs, undergo significant stresses when in use. Particularly modern, high speed, advanced-integration semiconductive devices generate a significant amount of heat during use. This heat can degrade and slow down semiconductive devices. For example, testing of semiconductive devices to determine the quality and capability of the devices can generate such heat within the devices that the testing process itself damages the devices. Typical fiberglass interposers do not dissipate heat sufficient to protect semiconductive devices from the potential of damage caused by the heat generated during use of the device.

In addition, typical fiberglass interposers are made of glass fibers and epoxy resin. The resulting interposer has a coefficient of thermal expansion which is incompatible with typical semiconductive devices. The coefficient of thermal expansion of the fiberglass is often significantly greater than that of the semiconductive device.

As a result of this thermal expansion incompatibility, shear stresses develop in the interface between the interposer and the semiconductive device when the semiconductive device becomes hot. These shear stresses can result in a severing of the electrical connection between the interposer and the semiconductive device. While it is possible to ameliorate the effects of shearing through a process known as wire bonding, this process adds additional

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

complexity and expense. Furthermore, the organic material within FR4 fiberglass interposers absorbs moisture, causing the interposers to degrade.

There is therefore a need in the art for an improved interposer which assists in protecting a semiconductive device coupled to the interposer from the potential damage caused by significant amounts of heat generated by the semiconductive device. There is also a need in the art for an improved interposer which prevents shear stress from severing the electrical connection between the interposer and the semiconductive device.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

SUMMARY OF THE INVENTION

An interposer of the present invention is comprised of (i) a substrate comprised of an electrically insulating, thermally conductive ceramic material; and (ii) an electrical conductor on the substrate having a receiving end for connecting to a semiconductive device and a terminal end for connecting to an electrical apparatus. The semiconductive device is electrically coupled to the electrical apparatus when the semiconductive device is connected to the receiving end of the electrical conductor and the terminal end of the electrical conductor is connected to the electrical apparatus. The invention also includes thermally conductive connections between the semiconductive device and an interposer.

In one embodiment, a thermally conductive connector connects the semiconductive device, such as an SRAM, DRAM, or integrated circuit device, to the interposer such that a portion of the semiconductive device is exposed to the atmosphere to thereby dissipate heat to the atmosphere. Both the thermally conductive interposer and the thermally conductive connector act as heat sinks to conduct heat from the semiconductive device to the ambient, thereby protecting the semiconductive device from overheating. The interposer preferably has a coefficient of thermal expansion which is substantially similar to the coefficient of thermal expansion of a semiconductive device on the interposer, thereby preventing shearing of the electrical connection between the semiconductive device and the interposer.

In one embodiment, the semiconductive device is fastened temporarily and removably to the interposer and the interposer is coupled to an electrical apparatus. In another embodiment, the semiconductive device is permanently coupled to the interposer. As an example of a connector, a biasing clip enables quick and convenient placement and removal of semiconductive devices on the interposer. The interposer may be permanently or removably coupled to the electrical apparatus, depending on the desired application.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

These and other features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the manner in which the above-recited and other advantages of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

Figure 1 is a perspective view of an interposer kit of the present invention showing one trace array empty, one trace array having a semiconductive device thereon, and one trace array having a semiconductive device thereon with a biasing connector coupling the semiconductive device to the interposer.

Figure 2 is a bottom surface view of a semiconductive device.

Figure 3 is a perspective view of a biasing connector of the present invention.

Figure 4 is a perspective view of another embodiment of a biasing connector of the present invention.

Figure 5 is a perspective view of the interposer kit shown in Figure 1 with an additional biasing connector and semiconductive device placed thereon.

Figure 6 is a cross-sectional, cut-away view of the semiconductive device and the interposer shown in Figure 1.

Figure 7 is a cross-sectional, cut-away view of another embodiment of a semiconductive device and interposer.

Figure 8 is a cross sectional, cut away view of the interposer of Figure 1 having an insulating layer on the intermediate portion of a conductor thereof.

Figure 9 is a schematic view of an electrical apparatus shown as receiving the interposer kit shown in Figure 5.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to Figures 1 and 2, the present invention relates to an interposer system 10 comprising (i) an interposer 12; and (ii) a connector 14 for connecting a semiconductive device 16 to interposer 12. Interposer 12 is configured to electrically couple semiconductive device 16 to an electrical apparatus (not shown in Fig. 1), such as a testing apparatus which monitors, tests or evaluates device 16, by for example storing information on device 16 and retrieving information from device 16.

Interposer 12 is electrically coupled to the electrical connections 17 of device 16, the bottom surface of which is shown in Figure 2, and to electrical connections on an electrical apparatus, thereby electrically coupling semiconductive device 16 to the electrical apparatus. By coupling semiconductive devices 16 on interposer 12, and coupling interposer 12 to the electrical apparatus, the electrical apparatus may perform a variety of functions upon the semiconductive devices, while the semiconductive devices are protected from overheating by the heat dissipating qualities of interposer 12.

Interposer 12 and preferably, connector 14, are thermally conductive. As shown in Figure 1, system 10 preferably exposes semiconductive device 16 partially to the open atmosphere, rather than completely covering devices 16 with a connector, allowing heat to dissipate to the atmosphere directly from semiconductive device 16. In addition, heat is transferred through thermally conductive interposer 12 and connector 14 from semiconductive device 16, then dissipated to the atmosphere. The thermal conductivity of interposer 12 and connector 14, along with the configuration of interposer 12 and connector 14 are significant advantages within the art.

Interposer 12 will now be discussed in additional detail. Interposer 12 is comprised of a substrate 18 and a plurality of electrical conductors 20 on substrate 18. Substrate 18 is comprised of an electrically insulating material. Substrate 18 also conducts heat, thereby dissipating heat away from device 16 connected to substrate 18. When exposed to the high

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

temperatures generated by advanced high density, high integration devices 16, substrate 18 does not warp or bow. Substrate 18 has formed thereon electrical conductors 20, such as metal traces. Substrate 18 also preferably has substantially similar thermal expansion properties as semiconductor device 16, such as a substantially similar coefficient of thermal expansion as that of semiconductive device 16. By having substantially similar thermal expansion properties, shear stress is reduced in the physical connections between device 16 and interposer 12 so as to prevent a severing of the electrical connection between device 16 and interposer 12.

In one embodiment, substrate 18 is comprised of a ceramic material, such as an inorganic ceramic material. Examples of ceramic materials used in the production of substrate 18 include glass. Many forms of glass may be used, including glass comprising silicates, silica, silicon oxide, phosphates, or borates, or derivatives thereof. Such glass may be doped with metal, an oxide or other elements, so long as it remains electrically insulative. Glass may be formed by fusing silica with a basic oxide, for example. Borophosphosilicate glass is one example of a material useful for substrate 18. Inorganic forms of glass are preferable. Glass materials often have substantially similar thermal expansion properties as semiconductive devices 16, which are often substantially comprised in the most part of silicon or other semiconductive material.

In addition to glass, other ceramics useful in the present invention as substrate 18 include alumina, aluminum nitrides, nonmetallic nitrides, nonmetallic carbides, single oxide ceramics, mixed oxide ceramics, and mixtures and derivatives thereof. As used throughout this specification and the appended claims, the term "nonmetallic nitrides" includes boron nitrides, silicon nitrides and other transitional element nitrides. Alumina, for example, may be used alone or in combination with silica or silicates, for example, because alumina resists harsh environments and also dissipates heat.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

Other examples of ceramics useful in the present invention for substrate 18 include glass ceramics, such as nucleated glass having a nonporous, substantially crystalline structure, devitrified ceramics, or vitro ceramics. In one embodiment, glass ceramics are fine-grained substantially crystalline materials made through controlled crystallization from glass compositions containing nucleating agents. Thus, in one embodiment, substrate 18 comprises a material selected from the group consisting of glass, alumina, glass ceramic, aluminum nitride, nonmetallic nitride, nonmetallic carbide, and mixtures and derivatives thereof. Other possible, but less preferred ceramics for substrate 18 include refractories such as steatite and mullite.

Glass and other ceramics are preferably provided in a substantially homogeneous form for substrate 18, as opposed to the heterogeneous mixture of fibers and epoxy found in FR4 fiberglass. Glass and other ceramics are also preferably provided in substrate 18 in a substantially planar (i.e., flat) sheet, as shown in Figure 1.

As shown in Figure 1, interposer 12 includes a plurality of arrays 22, 24, 26 of electrical conductors 20 thereon. Each electrical conductor 20 has a receiving end 28 for connecting to a corresponding terminal 30 of an electrical conductor 32 on the bottom surface of semiconductive device 16 as shown in Figure 2. Each electrical conductor 20 on substrate 18 further comprises a terminal end 34 for connecting to an electrical apparatus. An intermediate portion 36 of conductor 20 extends between receiving end 28 and terminal end 34 of each conductor 20. The connection of terminal end 34 to the electrical apparatus may be permanent or removable.

An interposer of the present invention may comprise a single conductor or a plurality of conductors. The interposer may have a single array of conductors or may have a plurality of arrays, such as arrays 22, 24, 26 as shown in Figure 1. Each array may have as many conductors as needed to electrically couple a particular semiconductive device, such as device 16, to an electrical apparatus. Conductors may have a variety of different

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

configurations any of which are designed to electrically couple a semiconductive device to an electrical apparatus. Heat dissipates to the environment through the conductors and from the conductors through the substrate to the ambient.

In one embodiment, the semiconductive device is permanently coupled to the interposer. The semiconductive device may be permanently coupled to the interposer through the use of an adhesive, for example, which is another example of a connector. In an underfilling process, adhesive is placed around the edges of semiconductive device 16 mounted on interposer 12, then the adhesive is permitted to wick through capillary action between interposer 12 and semiconductive device 16. This process can be repeated until the desired bond is achieved between interposer 12 and the semiconductive device 16. This underfilling process is often used for flip chips, for example. Preferably, the adhesive is a thermally conductive adhesive, such as a silver-filled epoxy, or a tape having acrylics filled with alumina or aluminum nitride with a matrix in resin. The thermally conductive adhesive enhances heat dissipation away from semiconductive device 16. Adhesives may be applied using a screen printing process, for example.

In another embodiment, semiconductive device 16 is removably coupled to interposer 12, such as when it is desired to test device 16 by coupling device 16 to testing apparatus which monitors, tests, and/or evaluates device 16. Preferably, when removability is desired, connectors such as resilient biasing connectors 14 are employed. As shown in Figure 1, biasing connector 14 connects device 16 to interposer 12 such that a substantial portion of device 16 is exposed to the open environment, thereby assisting in dissipating heat from device 16.

With reference now to Figures 3, 4, and 5, various embodiments of biasing connectors are demonstrated. As shown in Figure 3, connector 14 comprises a resilient clip having a top plate 38, a bottom plate 40, and an intermediate portion 42 coupling top plate

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

Docket No. 11675.168

38 to bottom plate 40. Connector 14 may be employed to resiliently, removably bias semiconductive device 16 against interposer 12.

Another embodiment of a connector 44 is demonstrated in Figure 4. Connector 44 comprises a resilient clip having an upper plate 46, a lower plate 48 and an intermediate portion 50 coupling upper plate 46 to lower plate 48. Each of plates 46, 48 include a bow in the central portion thereof. The bow in plates 46, 48 allowing front ends 52, 54 of clip 44 to be readily biased open and closed manually for placement over device 16 and substrate 12.

As shown in Figure 5, in one embodiment one connector 14 is used for a single semiconductive device 16, whereas in another embodiment a single connector 56 is used to couple a plurality of semiconductive devices 16 to interposer 12. Connector 56 may be in the shape of clip 14, clip 44, or a variety of other clips or other configurations. A variety of different designs of connectors may be employed in the present invention such as other clips, crimps, clamps and a variety of other connectors having shapes and configurations which allow them to resiliently, removably bias semiconductive devices 16 to interposer 12.

In a preferred embodiment, heat is also conducted through a thermally conductive connector to the environment. Biasing connectors 14, 44, and 56 are preferably comprised of a resilient, heat dissipating material such as copper, copper alloy, or another metal. The connectors are also insulated from the electrical connections on devices 16, such as by being further comprised of or coated with an electrically insulating material, such as glass or polymer or by being placed on electrically insulating portions of devices 16. The connectors thus resiliently, removably bias semiconductive devices 16 against interposer 12 while simultaneously assisting in dissipating the heat generated by devices 16 in conducting the heat to the atmosphere. These connectors do so in a manner which allows a portion of the device itself to be exposed to the atmosphere, thereby increasing the dissipative qualities of system 10.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

Connectors 14, 44, 56 dissipate heat because they are in intimate thermal contact with devices 16 and because they are comprised of a thermally conductive material. Connectors 14, 44, 56 and other such connectors may be placed on device 16 manually or automatically. One advantage of such connectors over an underfilling process is that the connectors do not need a delay time in which wicking occurs and they avoid the further delay of repeated applications, as well as delays associated with curing of the adhesive.

Connectors 14, 44, 56 or a variety of substantially similar connectors may also be employed to assist in permanently coupling devices 16 to substrate 18, thereby providing heat dissipation. For example, it is possible to employ both an adhesive, such as a thermally conductive adhesive and a connector, such as connector 14, 44, or 56 to permanently couple semiconductive device 16 to interposer 12. This may be accomplished, for example, by placing adhesive between substrate 18 and semiconductive device 16 with a connector 14, 44, or 56 to couple both substrate 18 and device 16 together and/or by placing the adhesive between connector 14, 44, or 56 and substrate 18, for example. Adhesive may also be placed between connector 14, 44, or 56 and device 16 so long as the electrical connections between connector 14, 44, or 56 and device 16 are preserved.

Conductors 20 may be conventionally formed on substrate 18 by being attached or deposited thereon. For example, a metal can be sputtered onto substrate 18, followed by a patterning process to define conductors 20. Other conventional metallizing or metal line deposition processes can also be used. In one embodiment, substrate 18 is initially etched, after which the etched portion is metallized, by metal deposition and a metal line patterning process. Metal deposition and photolithographic metallization processes may be used to etch fine line widths and to place conductors in dense arrays on substrates to form interposers.

As shown in Figure 6, in one embodiment, electrical conductor 20 has a bumped receiving end 28 which projects from the upper surface of substrate 18. In this embodiment, semiconductive device 16 includes a corresponding electrical conductor 32 having a bumped

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

terminal 30 which couples to receiving end 28, thereby forming a connection between bump 30 and bump 28 when device 16 and interposer 12 are connected together such that bumps 28 and 30 interface. This creates a physical connection between substrate 18 and device 16. This configuration allows bumps 28, 30 to slide against one another, permitting convenient coupling of bumps 28, 30 together as well as removal of bumps 28, 30 one from another.

In another embodiment, as shown in Figure 7, the electrical connection between an interposer 59 and a semiconductive device 58 is created by providing for a complimentary, male/female connection between device 58 and interposer 59. Although interposer 59 is shown as comprising the female fitting, the interposer may comprise the male fitting, as shown in Figure 6 with protruding bumped receiving end 28, while the semiconductive device comprises the female fitting which is formed in a recess of the semiconductive device.

In the embodiment shown in Figure 7, interposer 59 comprises a substrate 60 having a recess 62 therein. A conductor 64 such as a metal trace is placed on substrate 60 such that a receiving end 66 of conductor 64 is disposed within recess 62, which is below the upper surface of substrate 60, allowing a male connecting terminal 68 of a conductor on semiconductive device 58 to be electrically coupled with receiving end 66 by being placed therein. Conductor 64 also has a terminal end (not shown) for connecting to an electrical apparatus. A connector such as connector 14, 44, or 56 may then be placed to bias device 58 towards substrate 60 to thereby retain the electrical connection between bump 68 and recessed receiving end 66. It will be appreciated that the male/female complimentary fit shown in Figure 7 would be advantageous because of the structural integrity and non-slip design derived therefrom.

According to one method of manufacturing interposer 12 or 59, a substrate 18 or 60 of the present invention is provided comprising a ceramic material. At least one electrical conductor 20 or 64 is then coupled onto the substrate. In one embodiment, recess 62 is formed within substrate 60, such as through etching, and at least a portion of conductor 64

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

is placed within the recess 62. A recess may be formed to receive receiving end 66, as shown in Figure 7, the entire conductor, an intermediate portion of conductor 64 and end 66, or a variety of other portions of conductor 64.

As yet another feature of the invention, as shown in Figure 8, it is possible to form a layer 69, such as a coating, of an electrically insulating material on the intermediate portion 36 of electrical conductor 20 of interposer 12. The electrically insulating material for layer 69 may comprise an electrically insulating material, such as a polymer or resin. In one embodiment, the electrically insulating material is thermally conductive, such as a ceramic material such as described above (e.g., glass, aluminum nitride or alumina), for example. Thus, in one embodiment, layer 69 electrically insulates conductor 20 from contact with an electrical conductor, such as an uninsulated connector, and simultaneously aids in heat dissipation.

With reference now to Figure 9, interposer 12 having semiconductive devices 16 electrically coupled thereto through the use of connectors 14, 56 is electrically coupled to an electrical apparatus 70 such as a testing apparatus shown in a diagrammatic view in Figure 9. Interposer 12 may be permanently or removably coupled to apparatus 70.

As used throughout this specification and the appended claims, the term "electrical apparatus" refers to an apparatus which electrically couples to a semiconductive device. Examples of such apparatuses include a computer, program logic controller, electronic game assembly, a controlling module, and a testing apparatus which monitors, tests, or evaluates a semiconductive device. The testing apparatus may be a computerized testing apparatus, for example.

Apparatus 70 includes a socket, such as a printed circuit board socket, having electrical terminals onto which terminal ends 34 of conductors 20 of interposer 12 are placed. After terminal ends 34 of interposer 12 are placed into the socket, an electrical connection

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

exists between semiconductive devices 16 and apparatus 70, thereby allowing a user to test device 16 or otherwise engage in a variety of different functions.

Thus, one method for testing semiconductive device comprises providing an interposer having substrate comprised of an electrically insulating, thermally conductive ceramic material, electrically coupling the interposed to a semiconductive device, electrically coupling the interposer to a testing apparatus such that the testing apparatus is electrically coupled to semiconductive device, and then actuating the testing apparatus to electrically communicate with the semiconductive device.

A variety of different semiconductive devices may be electrically coupled to the inventive interposer. Examples of such semiconductive devices include DRAMs, SRAMs, integrated circuit devices, and the like, each of which has electrical conductors thereon such as bumps, lead fingers, or other package connections. The semiconductive devices, however, may be either packaged or non-packaged.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed and desired to be secured by United States Letters Patent is:

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111